NREL/TP.620.26247
May 1999

TOPICAL ISSUES BRIEF

Grid-Connected Renewable-Electric Policies in the European Union

Larry Goldstein, John Mortensen, and David Trickett

National Renewable Energy Laboratory
A national laboratory of the U.S. Department of Energy

The Topical Issues Brief series is sponsored by
DOE's Office of Energy Efficiency and Renewable Energy
Office of Power Technologies

Available to DOE and DOE contractors from:
Office of Scientific and Technical Information (OSTI)
P.O. Box 62
Oak Ridge, TN 37831
Prices available by calling 423-576-8401

Available to the public from:
National Technical Information Service (NTIS)
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161
703-605-6000 or 800-553-6847
or
DOE Information Bridge
http://www.doe.gov/bridge/home.html

Printed on paper containing at least 50% wastepaper, including 20% postconsumer waste

Contents

Figures

Abstract

During the 1990s, member countries of what is now called the European Union (E.U.) have aggressively promoted the expansion of grid-connected, non-hydro renewable-electric generation. Driving this promotion is a recognition that renewables play a strategic role in increasing energy security and energy diversity, providing economic stimulation and meeting environmental commitments to reduce atmospheric pollution and greenhouse gas emissions. The success of E.U. member country efforts is apparent in the increase of more than 200% in the installed base of non-hydro, renewable-electric generating capacity between 1990 and 1998. These efforts have substantially reduced the existing gap between installed renewable capacity in the United States and the E.U.

The dramatic increases in non-hydro renewable generating capacity within the E.U. may be partially explained by the current portfolio of policies that promote the domestic *development* and *deployment* of renewable-electric generation technologies. These policies are aimed at reducing the cost of renewable technologies, which remains a major barrier to their expanded use, and at reducing market risks by making investments in renewable technologies more favorable relative to conventional electric generation options.

Examination of the policy incentives responsible for the increase in renewable generating capacity yields the following observations:

- The most commonly applied policies use research and development.
- With the exception of Luxembourg, all E.U. countries provide public support for renewable energy technology research, development, and demonstration.
- Significant deployment advances have occurred where preferential feed-in tariff rates or competitive market bidding requirements have been mandated.
- Consumer education programs also promote public support for renewables.
- The most successful countries use a fully integrated suite of policies.

Acknowledgements

Grid-Connected Renewable-Electric Policies in the European Union was prepared by Larry Goldstein, John Mortensen, and David Trickett of the Energy Analysis Office of the National Renewable Energy Laboratory (NREL) for the Office of Power Technologies of the U.S. Department of Energy (DOE). The authors would like to acknowledge Joe Galdo, DOE, for the personal support and guidance he provided to this project.

They also wish to thank the following reviewers for their comments and suggestions: NREL, Eldon Boes, Pat Keegan, Paul Galen, Bill Babiuch, and Kevin Porter; DOE, Joe Galdo; Worldwatch Institute, Chris Flavin; International Energy Agency, Jane Ellis; Parlamentsklub der ÖVP Parlamentsklub der ÖVP, legislative staff members Birgit Hollnbuchner and Mrs. Johanna Huber-Hochradl; the Embassy of Austria, Science and Technology Attachee Isabel Wolte; and Austrian Energy Agency, Michael Cerveny and Gustav Resch.

Grid-Connected Renewable-Electric Policies in the European Union

I. Introduction

Recognizing the variety of benefits attributable to renewables, member countries of what is now called the European Union (E.U.)[1] have aggressively promoted grid-connected, non-hydro renewable-electric technologies during the past decade. Driving this commitment is the recognition that renewables have a strategic role in increasing the E.U.'s energy security— moving away from gas and oil imports; providing economic benefits to local and regional economies and through renewable technology export opportunities; and meeting environmental commitments to reduce atmospheric pollution and greenhouse gas emissions. The E.U.'s efforts to develop and deploy renewable technologies have resulted in an increase of more than 200% in the installed base of non-hydro renewable-electric generating capacity between 1990 and 1998.

Renewable-electric generation growth has been achieved through a mix of policy measures and actions. Although varying widely in implementation among the E.U. member countries, the most commonly used policy measures include:

- Direct government investment in renewable technology development through research, development, and demonstration programs
- Government incentives to facilitate technology deployment.

The latter include such policy tools as commercialization incentives designed to lower the capital cost of renewables through loans, tax credits, grants, and subsidies; production incentives such as preferential feed-in rates for purchase of renewable electricity production; competitive market bidding; and consumer education and outreach.

Complementary actions to encourage renewables deployment have also been proposed at the E.U. Commission level. For example, non-binding targets have been established which, if achieved, will more than double the E.U. share of primary energy produced by renewable sources to 12% by 2010 and in the electricity sector increase the renewables share of electricity production from 14% to 24% in 2010. The resulting decrease in carbon dioxide (CO_2) emissions from the electricity sector is an important component in the overall E.U. plan for meeting the Kyoto target.[2]

The purpose of this Topical Issues Brief is threefold: first, to examine recent trends in the deployment status of renewable-electric technologies in the E.U. relative to the U.S.; second, to review and summarize several of the key E.U. policy measures that collectively appear to be linked to renewable development and deployment success; and third, to present several summary observations that provide "lessons learned."

This brief will focus primarily on non-hydro renewables. The hydroelectric market share of electric generation in both the U.S. and E.U., while large in contrast to non-hydro renewables, is not expected to have much growth due to environmental, regulatory, and developmental constraints. Accordingly, policy issues are different from those affecting non-hydro renewables. Being less mature and often more expensive than conventional fossil generation, non-hydro technologies require a full range of government support and incentives to successfully penetrate the marketplace in significant quantities.

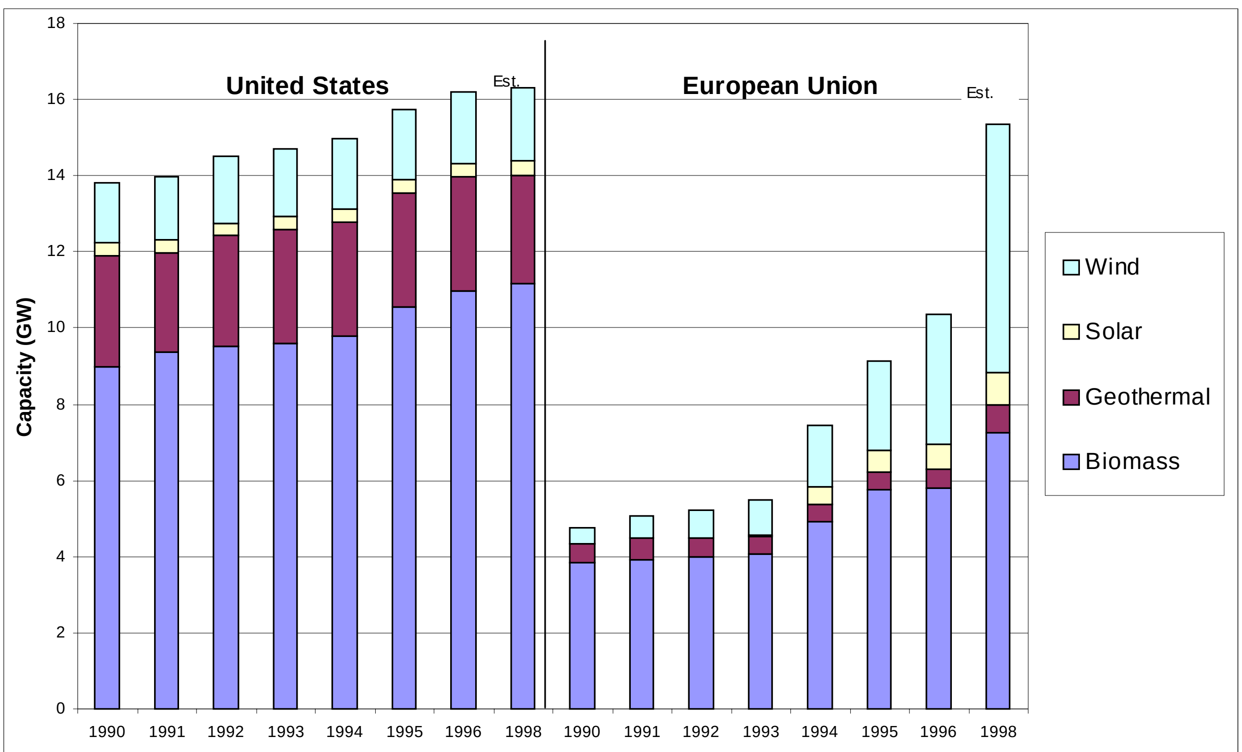
II. Status of Non-Hydro Renewables in the European Union and the United States

Examining installed, grid-connected generating capacity data, three immediate observations are clear. First, during the 1990s, non-hydro renewable-electric generation capacity has grown much more rapidly in the E.U. than in the U.S. Second, most of the growth in the E.U. is due to an increase in wind and biomass installations—wind primarily in Germany and biomass in Italy and Sweden.

Third, the number of countries that obtain a greater share of generating capacity from non-hydro renewables than does the U.S. has increased: eight countries today versus only one in 1990.

Figure 1 indicates that although the E.U. *total* amount of installed, non-hydro renewable-electric generating capacity remains lower than but close to that of the U.S., its *growth* rate during most of this decade has been significantly higher. For example, during the past 8 years, installed, non-hydro capacity in the U.S. has grown by roughly 20% while in the E.U. it has increased by more than 200% (see Appendix A). This growth is primarily attributable to increases in installed wind and biomass capacity.

Wind-generating capacity has increased at an average annual rate of 40% during the last 8 years with Germany setting the pace—installed wind capacity has grown from 28 megawatts (MW) in 1990, to 2,000 MW in 1997, to an estimated 2,800 MW in 1998.[3] The huge leap in wind capacity additions has



Source: IEA, OECD Electricity Information, 1997; 1998 geothermal and wind are from published data; biomass and solar are estimated values.

Figure 1. Grid-Connected Electric Generating Capacity for Non-Hydro Renewables in the European Union and the United States

allowed Germany to overtake the U.S. as the world leader in wind generation capability. Wind capacity is also growing rapidly in Denmark, Spain, and the United Kingdom.

The growth in biomass electric generation capability has also been significant, amounting to nearly 3,400 MW during the last 8 years—roughly doubling the existing capacity base. The cumulative growth of Germany and Denmark's wind generation capacity, and Sweden and Italy's biomass capacity, accounted for nearly half of all grid-connected renewable additions in the E.U. between 1990 and 1998.

In a number of E.U. member countries, the percentage share of total grid-connected generating capacity from non-hydro renewables contribution has also expanded dramatically during this decade. Figure 2 shows the estimated percentage of installed electric generating capacity from non-hydro renewables by country and technology for 1998. Eight countries (Denmark, Finland, Germany, Ireland, Italy, the Netherlands, Portugal, and Sweden) have higher percentage contributions (2.2% to 14.9%) than the U.S. does (2.1%). In 1990, only Denmark had a higher percentage contribution.

III. European Union Policies to Promote Development and Deployment of Renewable-Electric Technologies

The dramatic increase in non-hydro renewable generating capacity in the E.U. may be partially explained by the portfolio of policies that promote renewable-electric generation technologies. These policies are aimed at reducing the cost of renewable technologies, which remains a major barrier to their expanded use, and at reducing market risks by making investments in renewable technologies more favorable relative to conventional electric generation options. Member countries do not

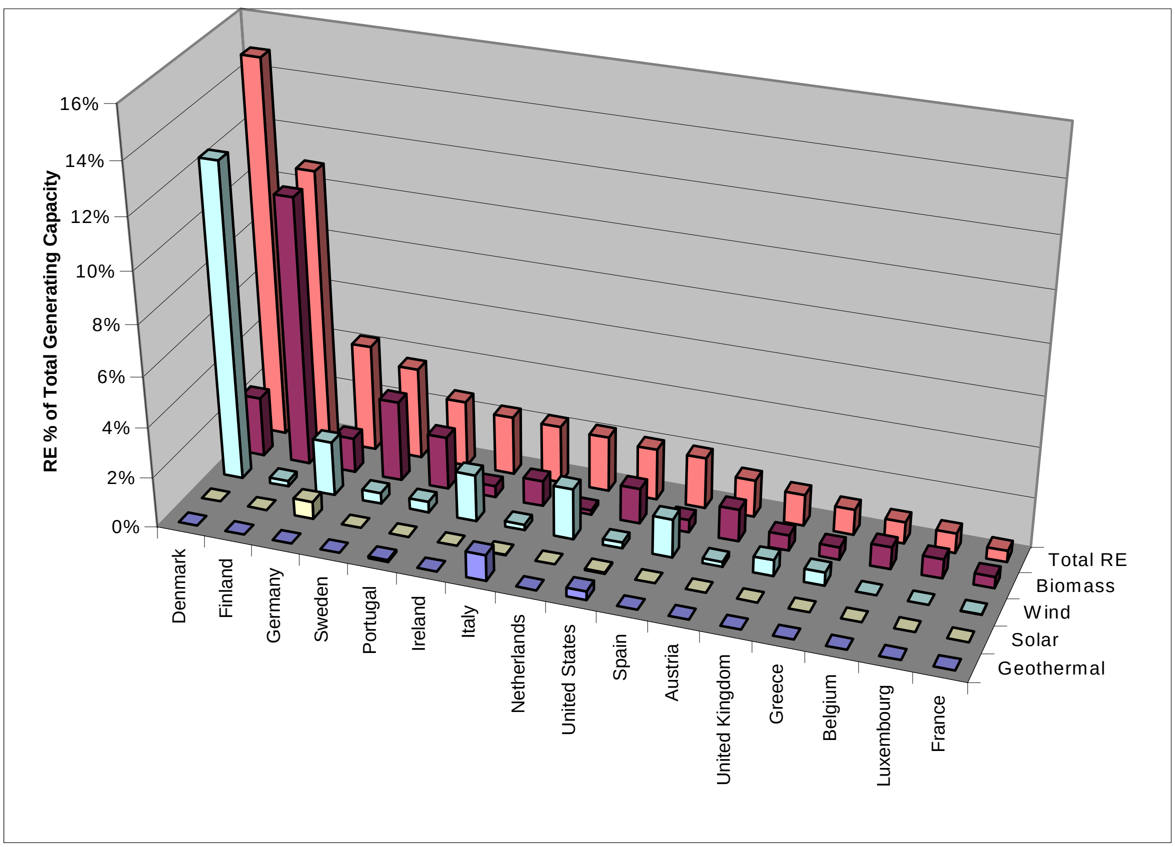


Figure 2. Non-Hydro Renewables as Percentage of Electric Generating Capacity (1998)

implement all of the policies in the same manner or to the same degree, and not all are implemented as part of an integrated set, or portfolio, of policies. This is an important consideration because the degree of consistency between programs and policies may affect the penetration of renewables into the market. The following section addresses what appear to be the most commonly used policies.

Investments in Renewable Technology

The amount of government funding for renewable energy research, development, and demonstration (RD&D) varies greatly over time and across countries. For example, the U.S. government's commitment to fund renewable energy technology RD&D reached a low in 1990 and has risen modestly in the 10 years since.

In 1980, U.S. federal support for non-hydro renewable energy RD&D amounted to $1.2 billion, about three times that of the total combined funding from member countries of the E.U. (see Appendix B). However, by 1996 (the last year available for published International Energy Agency [IEA] statistics) the amount had dropped below $300 million, about the same level as the combined funding of E.U. member countries. Increased private RD&D investment has not compensated for the decline in U.S. federal funding, as would generally be expected in a more mature and profitable industry. The falloff in U.S. funding also coincides with a decrease in domestic development. Both declines are symptomatic of a lack of national commitment to the development and deployment of renewable energy technologies.

The importance placed on renewable technology RD&D by E.U. member countries is indicated by its widespread support. With the exception of Luxembourg, which has no RD&D budget, all of the other member countries support this policy measure to some degree. As illustrated in Figure 3, which compares a 1-year (1996) snapshot of RD&D investment per unit of gross domestic product (GDP) for member countries and the U.S., five countries (Denmark, Finland, the Netherlands, Germany, and Sweden) had greater per GDP investments in renewables than the U.S. These countries also had greater percentages of renewable generating capacity than the U.S.[4]

In addition to a wide variation in renewables RD&D funding among E.U. countries, the technologies supported also vary.

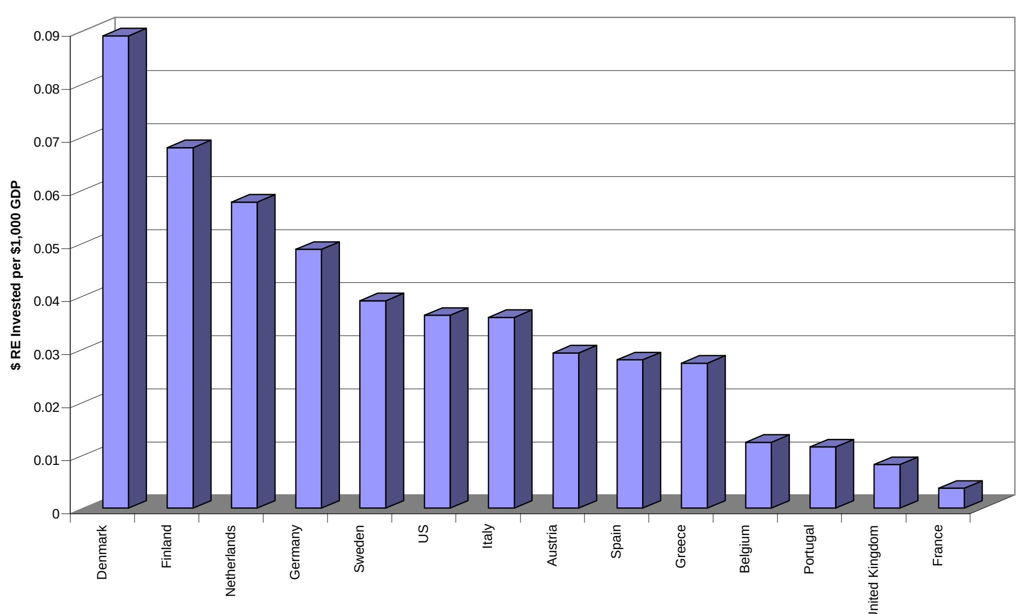


Figure 3. Governmental Investment in Renewable Energy RD&D per Gross Domestic Product (1996)

For example, photovoltaic (PV)-electric RD&D receives the largest funding in four countries (Belgium, Germany, Italy, and the Netherlands). The major investors in wind are Germany, Denmark, and Italy, together accounting for more than three-quarters of the total E.U. member countries' expenditures in this area. Biomass RD&D is dominated by Italy and Switzerland; geothermal is mostly supported by Switzerland and Germany; and solar thermal is supported by Spain, which invests more than 50% of its RD&D budget in this area.

The programs of the E.U.'s individual member states are supplemented by activities carried out by the European Commission itself for the benefit of member countries, primarily through the non-nuclear energy JOULE-THERMIE programs. Renewable energy is one of four areas supported by these programs (other areas include energy strategy, rational use of energy, and fossil fuels). Both programs require cost sharing of as much as 50% and are targeted at improving the security of the energy supply, protecting the environment by reducing the negative impact of energy use (in particular the emissions of CO_2), and encouraging the rational use of energy.

The JOULE program is research and development (R&D) oriented whereas the THERMIE program primarily funds demonstration projects involving innovative clean-energy technologies as well as information dissemination, training, and outreach. Under the non-nuclear energy JOULE and THERMIE programs for 1995-1998, the largest tranche of funding is for renewable energy—about 44%, representing roughly 460 million ECU ($530 million U.S.). This funding is projected to increase slightly to 480 million ECU ($550 million U.S.) for the period 1999-2002 (under the Fifth Research Technology Development Framework Program).

Wind energy has been one of the major renewable-electric technologies supported by the THERMIE program. Between 1983 and 1997, about 240 wind demonstration projects, representing roughly 64 MW, have been funded in the amount of $102 million ECU ($118 million U.S.). As expected, companies from Denmark have been the most active participants, followed by companies from Germany, France, and the United Kingdom.

European Union Incentives to Promote Deployment and Commercialization

As a complement to RD&D policies, E.U. countries employ a variety of policy measures to lower the cost of renewable-electric technologies to competitive levels, reduce financial risks, and further stimulate and condition the marketplace. These tools include commercialization incentives, production incentives, and consumer education.

***Commercialization Incentives*: ** Direct, government-funded subsidies are widely used by E.U. member countries to defray the higher, up-front capital costs of renewable-electric technologies. These measures include grants, low-interest loans, and tax incentives. The most prevalent of these measures, provided by almost every member of the E.U., are capital grants targeted to specific renewable energy technologies. Currently, most grants appear to be for PV systems. Ranging from less than 10% of capital costs in the United Kingdom to 90% of the capital cost for certain grid-connected PV systems in France, the average grant falls within the range of 40% to 60% for most countries.[5] Grants are also available for other renewable-electric technologies, including small-scale hydro and geothermal (30% of capital costs in Spain), wind (as much as 25% of capital costs in Germany), and biomass (as much as 30% capital costs in Italy).

Below-market rate loans are also a commonly used mechanism to finance construction of renewable-generation projects. In Austria, 4.5%, 15-year loans are available for agriculture cooperatives to stimulate biomass power development. In Germany, special investment assistance is available through the Deutsche Ausgleichsbank in the form of loans at rates 1%-2% lower than those offered in the capital market. Interest rates are fixed throughout the loan term, which usually does not exceed 12 years but may range to 20 years.[6] In addition, a grace period for loan repayment can be granted for as much as 5 years. In Spain, grants or loans of as much as 30% of capital cost are available from the Institute for Energy Diversification and Conservation.[7] Portugal provides interest-free loans for all renewables generation, amounting to 40% of the total capital and development costs. No repayment is required for 3 years, with full repayment in 9 years.

Green Investment Fund Programs provide another mechanism to raise capital from mostly private investors at below-market rates for renewables projects. Under a program operating in the Netherlands, the government makes interest and dividends from investments in "green" projects tax exempt. This makes it possible for yields from green investments to be lower than competing non-green investments while remaining attractive to investors. The fund is able to provide loans for renewable-electric generation projects at 1% below market rates. In 1997, private lenders in the Netherlands placed a total of $265 million (U.S.) into green projects, e.g., renewable power technologies. These programs are available in several countries including the Netherlands, Denmark, Sweden, and Germany.[8]

Tax incentives are also a means of effectively reducing costs. For example, most E.U. member countries provide for a reduced, value-added tax on electricity produced from renewable energy resources or for reductions in the energy taxes levied on power plants due to their CO_2 emissions. Other forms of country-specific tax incentives include:

- Greece—tax deductions of as much as 100% for cost of purchasing and installing renewable capacity, higher depreciation rates, lower social security contributions, and favorable tax rates for renewable energy technologies.[9]
- Italy and Denmark—tax exemptions for investments in certain types of renewable energy technologies.
- Portugal—reduced value-added tax and other tax deductions for renewables equipment.[10]

The European Commission is also considering flexible depreciation of renewable energy investments and favorable tax treatment for third party financing of renewable energy projects.

***Production Incentives*:** Government-mandated feed-in or buy-back rates and competitive-market bidding are the two most widely used mechanisms by E.U. member countries to stimulate deployment of renewable-electric generation.

Renewable energy feed-in rates (in Germany, the renewable energy feed-in tariff or REFIT), are government-set purchase prices, usually expressed as a fixed percentage of the retail electric price, which all utilities must pay for electricity produced from qualifying renewable energy facilities. Moreover, in some countries the feed-in laws obligate electric utilities to provide renewable-generation technologies access and interconnection to the grid system.

Several E.U. member governments have enacted preferential feed-in rates that range as high as 90% of the average retail consumer electricity price[11] (see Appendix C for more detail). Considering that the retail price of electricity in most E.U. countries is significantly higher than in most of the U.S., it is evident that these rates provide producers an incentive to promote growth in renewable generation. The combination of guaranteed markets, profitable feed-in rates, and, where applicable, grid access, reduces project financing uncertainties and risk, thus making these much more attractive to potential developers and investors.

Germany and Denmark are good examples of nations where this approach has been successful in driving wind energy development. In Germany, wind energy generators receive 90% of the government-set price of electricity. In 1997 the average feed-in rate for wind-generated electricity was 0.1721 DM/kilowatt-hour (kWh) (U.S. $0.10/kWh). In Denmark, the feed-in rate for wind generators is set at 85% of the price of electricity to consumers. This rate includes a production subsidy and partial energy tax offset payment. The average rate received by wind generators in 1997 was DKr 0.58/kWh (U.S. $0.09).[12] These rates are for the life of the project.

Other examples of feed-in rates and conditions established in E.U. countries include:

- Italy— for wind-generated electricity, $0.10/kWh for an 8-year period. For biomass/PV generated electricity, $0.15/kWh for an 8-year period. These figures were for projects accepted through 1997.[13]
- Spain—for biomass-generated electricity, $0.07/kWh for 5 years. For wind/PV-generated electricity, $0.08/kWh for 5 years. In November 1997, a new and more liberal law (54/1997) was put into place setting all renewable feed-in rates (starting in late 1998) between 80% and 90% of the average electricity price.[14]
- Portugal—$0.07/kWh for all renewables during an 8-year period.
- Greece—as much as $0.06/kWh for all renewables during a 10-year period.
- Austria—for wind/PV-generated electricity, between $0.03 and 0.08/kWh. For biomass-generated electricity, $0.03-0.07/kWh, with actual rate depending on the season.[15]
- Sweden—$0.032/kWh for all renewables. Also, an environmental bonus ($0.018/kWh) is paid to small wind projects (< 100 kW).[16]

The somewhat lower rates in countries such as Greece and Sweden have proven less effective as a means of stimulating renewables.[17] However, rates for biomass in Austria, also not the highest offered in the union, have proven profitable enough to be a successful incentive to the deployment of this particular technology. In general it is important that, besides being high enough to provide a profit incentive, rates must also be guaranteed for a long enough duration to provide investors with an acceptable return on investment.[18]

Competitive-market bidding represents the second most popular mechanism for stimulating the production of electricity from renewable energy sources. Regulators specify the capacity block (MW) and the maximum (premium) price per kWh, and the renewable electricity project developers submit competitive price bids, within a technology band, for contracts. Successful project bidders are guaranteed their bid price for a specified period, typically 15 years. The difference between the bid and market reference price is subsidized by a national levy on fossil fuels.

The United Kingdom's Non-Fossil Fuel Obligation (NFFO) is one example of this approach and is the main policy instrument in the United Kingdom for pursuing the development of renewable-electric generation capacity. From the program's beginning in 1990-1998, more than 500 MW (representing nearly three-quarters of the installed non-hydro renewables capacity base) has been developed through this process.[19] The NFFO appears to be on schedule to meet its goal of deploying an additional 1,000 MW of renewable capacity by 2000,[20] and between 1990 and the first quarter of 1997, $650 million was devoted to this program.[21]

It is important to note, however, that the NFFO is not without significant transaction costs. There is also evidence that it may encourage competing projects to bid below cost (in order to capture contracts), with the result that successful bidders are unable to meet the terms of the bid or end up insolvent. Comparable forms of the NFFO are also used in Northern Ireland, Scotland, and France.

***Public Education*:** Education programs seek to increase the public's understanding of renewables technologies and encourage energy providers to disclose renewable energy information. At the E.U. level, promotion of renewables has been supported by the Altener program, which provides 30%-50% of eligible costs for selected projects. Eligible actions include studies and technical evaluations to assist in defining standards/ specifications and training and consumer information activities. A total of ECU 40 million ($46 million U.S.) was available for the period 1993-1997. A successor, Altener II, has been approved with a budget of ECU 30 million ($35 million U.S.) for the first 2 years. Included among the measures to be supported under Altener II are consumer information dissemination and exchange.

Education campaigns, which also occur within individual member countries and in various media forms, are directed toward different target groups.[22] In the Netherlands, renewable energy education is part of a broader environmental awareness campaign. In Austria, renewable energy education occurs in schools and universities. In Finland, renewable energy education is part of the strategic planning process for utility RD&D. Belgium is conducting public advertising campaigns. Renewable energy advice centers are available to the public in Germany and Greece, and a biofuels advice center is available in Portugal.

Most renewable-electric generation projects are locally owned in the E.U. member countries. For example, 70% of the wind projects in Denmark are owned by wind cooperatives whose membership is made up of local citizens who have made an investment in the wind facility. This contributes to a greater public understanding and appreciation of these technologies and their economic and environmental benefits.

IV. Summary Observations

The E.U. and member countries are committed to increasing the proportion of electricity generated by non-hydro renewables. During this decade, rapid growth has been achieved by applying a portfolio of policy incentives (see Appendix D) that ensures renewable-electric generation technologies are used—above and beyond the limits dictated by purely market considerations. As a result, the E.U. is on a path to becoming *the* world leader in renewable-electric technologies use. Examination of the policy incentives responsible for this momentum yields the following observations:

1. All E.U. member countries (with the exception of Luxembourg) provide public support for renewable energy technology RD&D. Although the specific portfolio of technologies funded varies with each country, electric generation using PV, wind, and biomass generally receives the most public support.

2. Significant deployment advances have occurred where preferential feed-in tariff rates or competitive market bidding requirements have been mandated. Preferential rates have been the major impetus to the increases in renewables deployment predominantly from wind resources. Purchase obligations using a competitive bidding system have likewise added significant capacity in the United Kingdom.

3. Consumer education programs are widespread and are targeted by member countries to promote local public support for renewables.

4. The most successful E.U. member countries use a fully integrated suite of policies— Germany, for example, heavily promotes the deployment of wind by aggressively funding the necessary RD&D; providing tax incentives; offering long-term, preferential feed-in tariff rates; and providing consumer education regarding the benefits of renewables.

Appendix A
Electric Generating Capacities and Annual Growth Comparison Charts

Electric Generating Capacities (GW)					
	Biomass	Geo-thermal	Solar	Wind	Non-hydro total
European Union					
1990	3.84	0.51	0.00	0.41	4.76
1991	3.90	0.58	0.01	0.56	5.05
1992	4.00	0.48	0.01	0.73	5.22
1993	4.06	0.48	0.02	0.92	5.48
1994	4.90	0.49	0.46	1.59	7.44
1995	5.74	0.49	0.56	2.36	9.15
1996	5.80	0.51	0.65	3.42	10.38
1998	7.25	0.75	0.84	6.20	15.04
United States					
1990	8.99	2.91	0.36	1.55	13.81
1991	9.36	2.61	0.36	1.65	13.98
1992	9.52	2.90	0.34	1.75	14.51
1993	9.60	2.97	0.36	1.78	14.71
1994	9.80	2.97	0.36	1.83	14.96
1995	10.54	3.02	0.35	1.84	15.75
1996	10.96	3.00	0.36	1.88	16.20
1998	11.17	2.85	0.37	1.93	16.32

Annual Growth in Electric Generating Capacities					
	Biomass	Geo-thermal	Solar	Wind	Non-hydro total
European Union					
1990-91	2%	14%		37%	6%
1991-92	3%	-17%	0%	30%	3%
1992-93	1%	0%	100%	26%	5%
1993-94	21%	2%	2200%	73%	36%
1994-95	17%	0%	22%	48%	23%
1995-96	1%	4%	16%	45%	13%
1996-98	25%	47%	29%	81%	45%
Average Growth	9%	6%	296%	43%	16%
Total Growth	89%	47%	NA	1412%	216%
United States					
1990-91	4%	-10%	0%	6%	1%
1991-92	2%	11%	-6%	6%	4%
1992-93	1%	2%	6%	2%	1%
1993-94	2%	0%	0%	3%	2%
1994-95	8%	2%	-3%	1%	5%
1995-96	4%	-1%	3%	2%	3%
1996-98	2%	-5%	3%	3%	1%
Average Growth	3%	0%	0%	3%	2%
Total Growth	24%	-2%	3%	25%	18%

Appendix B

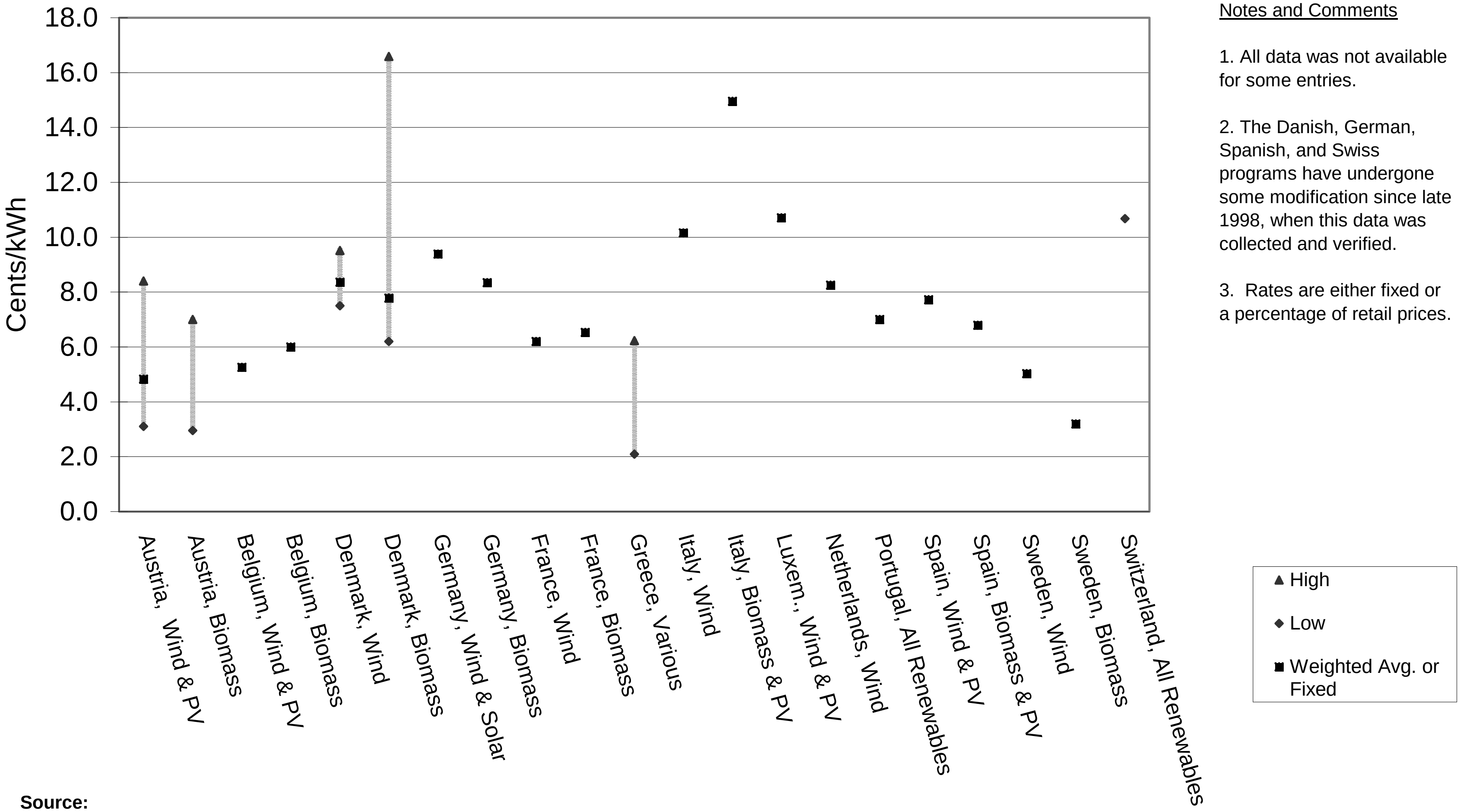
Renewable Energy R&D Funding Comparison Chart

Renewable Energy R&D Funding 1980-1996 ($million)			
Year	E.U. Nations	United States	U.S./E.U. Ratio
1980	$423	$1,205	2.9
1981	$496	$1,077	2.2
1982	$484	$517	1.1
1983	$375	$390	1.0
1984	$478	$317	0.7
1985	$356	$290	0.8
1986	$264	$214	0.8
1987	$266	$194	0.7
1988	$293	$152	0.5
1989	$280	$133	0.5
1990	$339	$123	0.4
1991	$330	$164	0.5
1992	$312	$227	0.7
1993	$337	$218	0.6
1994	$248	$328	1.3
1995	$282	$388	1.4
1996	$261	$268	1.0

Note: The above figures are aggregates of spending by the individual E.U. member states; they do not include spending by the E.U. Federation itself.

Sources:
IEA, AD1980-1995: IEA Energy Technology R&D Statistics: 1974-1995, Organization for Economic Cooperation and Development/(OECD)IEA 1997.
IEA, Paris.1996: IEA fax 6/16/98.

Appendix C
Renewable Electricity Feed-in Tariffs for European Union Countries



<u>Notes and Comments</u>

1. All data was not available for some entries.

2. The Danish, German, Spanish, and Swiss programs have undergone some modification since late 1998, when this data was collected and verified.

3. Rates are either fixed or a percentage of retail prices.

Source:
Michael Cerveny and Gustav Resch. "Feed-in Tariffs and Regulations Concerning Renewable Energy Electricity Generation in European Countries." *Energieverwertungsagentur.* Vienna, Austria, August 1998; Eurosolar. *Eurorule.* RENA-CT94-0020. 1996; IEA. Renewable Energy Policy in IEA Countries: Volume 1, Overview. Paris, 1997.

Appendix D

Summary of Renewable Energy Policies by Country[23]

Country	Capital Grant	Capital Subsidy	Capital Loans	Education	Feed-in or REFIT	Green Pricing	Grid Access	Zoning	Tax Incentives	RE RD&D $/GDP	RE % of Elec. Capac.
Austria		To 40% for PV	4.5%, 15 yrs. (bio)	Schools, universities	PV wind/PV 4.3-5.3¢/kWh biomass 3-7¢/kWh		Cost left to utilities			29	1.5%
Belgium		15% in Flanders	Yes, no details avail.	Publication, advertising	1/3 end-user rate		Producer pays			12	0.9%
Denmark	To 30% for solar, biogas	15% to replace turbines		Yes, no details avail.	Biomass 6.2-16.6¢/kWh Wind 9¢/kWh	Yes, no details avail.	Connection: Producers; Grid Enhance-ment: Utility	Wind-siting proposals required	CO_2 tax reimburse 0.1 DK/kWh	89	14.9%
Finland		To 50% for PV		Yes, no details avail.	Avoided costs				Bio favored	68	10.9%
France	Yes, no details avail.	To 90% for rural off-grid PV	Yes, no details avail.		PV 4.6 ¢/kWh NFFO		No standards		Bio excise exemption; Wind credit	4	0.7%
Germany	To 60% for wind	40%-80% for PV	1%-2% below cap market rate (wind)	RE advice centers	Biomass ≥ 80% Avg. revenue i.e., 8.3¢/kWh Wind/solar ≥ 90% avg. revenue i.e., 9.4 ¢/kWh	Yes, no details avail.	200%-500% cost increase	2 years to zone for wind	Bio tax exempt	49	4.2%
Greece		45%-55%		RE advice centers	Approximately 6¢/kWh				Allowance Depreciation; favored tax rates	27	1.0%
Ireland	Yes, no details avail.				NFFO			Considering wind-siting policy		NA	2.3%
Italy		30%-80% for PV			Biomass/PV 10¢/kWh Wind15¢/kWh				Bio tax exempt	36	2.5%
Luxembourg					Wind/pv ≤ 500 kW 10.7¢/kWh					NA	0.8%

Sources:

Eurosolar. *Eurorule*. RENA-CT94-0020. 1996.
IEA. *Renewable Energy Policy in IEA Countries: Volume 1, Overview*. Paris, 1997, p 47.
Richard L. Wynn. *Summation of Domestic Policies and Export Policies of Renewable Energy Systems*. NREL: TAK-6-16014-01. Golden, CO: National Renewable Energy Laboratory, December 1996.
D. Milborrow, G. Hartnell & N. Cutts. "Renewable energy in the E.U." *Financial Times Energy*. London, England, 1998.
Michael Cerveny and Gustav Resch. "Feed-in Tariffs and Regulations Concerning Renewable Energy Electricity Generation in European Countries." *Energieverwertungsagentur*. Vienna, Austria, August 1998.

Appendix D (continued)

Country	Capital Grant	Capital Subsidy	Capital Loans	Education	Feed-in or REFIT	Green Pricing	Grid Access	Zoning	Tax Incentives	RE RD&D $ per GDP	RE % of Electric Capac.
Netherlands		40%-60% for PV grid		Television	Retail electricity price (wind)	20% premium		Silent areas		58	2.5%
Portugal		To 40%		Biomass center	7¢/kWh				Lower VAT	12	2.6%
Spain		To 50%	To 30%; 3rd-Party financing		Biomass 7¢/kWh Wind/PV 8¢/kWh					28	2.0%
Sweden	To 25% for biomass	To 50% PV 35% wind		Yes, no details avail.	Approx. 3¢/kWh	10%-12% proposed				39	3.6%
United Kingdom				Yes, no details avail.	NFFO	10% proposed				8	1.3%

Sources: See previous page.

Endnotes

[1]E.U. members at the time of this writing include: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden, and the United Kingdom.

[2]The E.U. committed itself to achieving a carbon emission level 8% below 1990 levels by 2010 at the third conference of the UNFCCC (Kyoto December 1997). In the *Green Paper on Renewables* (1996), the Commission sought views on a renewables target of 12% of inland energy consumption and 24% of electricity production by 2010. In its “White Paper for a Community Strategy and Action Plan,” *Energy for the Future: Renewable Sources of Energy*, 1997, it adopted these levels as political (not legally binding) goals (pp.6-7).

[3]Source for 1997/1998 data: *American Wind Energy Association News*, April 10, 1998, and January 15, 1999.

[4]Data are not available for Ireland.

[5]International Energy Association. *Enhancing the market deployment of energy technology: A survey of eight technologies*. Paris, 1997, pp.64-65.

[6]Eurosolar. *Eurorule*. RENA-CT94-0020. 1996.

[7]IEA. *Renewable Energy Policy in IEA Countries: Volume 1, Overview*. Paris, 1997, p.47.

[8]Original data (Fl 550m) are drawn from: D. Milborrow, G. Hartnell & N. Cutts. “Renewable Energy in the E.U.” *Financial Times Energy*. London, England, 1998, pp.218. Currency was converted to U.S. dollars using exchange rates for April 20, 1999.

[9]NTDB. *Renewable Energy Equipment*. NTDB ISA951201, December 1, 1995.

[10]*Ibid.*

[11]Eurosolar. *Eurorule*. RENA-CT94-0020, 1996, p.xli.

[12]The feed-in rate varies according to the area, and ranges between DKr 0.26 and 0.42/kWh. The subsidy (consisting of a reimbursement of the energy/carbon tax and an additional subsidy for renewables) is set at DKr 0.27/kWh. Source: Michael Cerveny and Gustav Resch. “Feed-in Tariffs and Regulations Concerning Renewable Energy Electricity Generation in European Countries.” *Austrian Energy Agency*. Vienna, Austria, August 1998, p.5.

[13]Michael Cerveny, Gustav Resch. “Feed-in Tariffs and Regulations Concerning Renewable Energy Electricity Generation in European Countries.” *Energieverwertungsagentur*. Vienna, Austria, August 1998.

[14]*Ibid.*

[15]*Ibid.*

[16]*Ibid.*

[17]Eurosolar. *Eurorule*. RENA-CT94-0020, 1996, pp.51-61.

[18]Eurosolar. *Eurorule*. RENA-CT94-0020, 1996, pp.51-62.

[19]D. Milborrow, G. Hartnell and N. Cutts. “Renewable energy in the E.U.” *Financial Times Energy*. London, England, 1998, p.292.

[20]Cranfield Wind Turbine Research Group. *Current Developments in the UK*. England: School of Mechanical Engineering, Cranfield University. 1997, http://www.cranfield.ac.uk/sme/ppa/wind/lectuknow.html.

[21]Michael Cerveny and Gustav Resch. “Feed-in Tariffs and Regulations Concerning Renewable Energy Electricity Generation in European Countries.” *Energieverwertungsagentur.* Vienna, Austria, August 1998, p.20.

[22]IEA. *Renewable Energy Policy in IEA Countries. Volume I, Overview*. Paris, 1997.

[23]Data are drawn from a variety of sources cited throughout the text. Renewable energy R&D $ is government R&D funding per million $ of gross domestic product. Renewable energy % of electric generating capacity is for non-hydro renewables in 1998.

Topical Issues Briefs Previously Published by the National Renewable Energy Laboratory*

Green-Power Marketing in Retail Competition:
An Early Assessment
March 1999
NREL/TP-620-25939

The New Hampshire Retail Competition Pilot Program
and the Role of Green Marketing
November 1997
NREL/TP-260-23446

Green Marketing in the Massachusetts Electric Company
Retail Competition Pilot Program
October 1997
NREL/TP-460-23507

Power Marketing and Renewable Energy
September 1997
NREL/SP-460-21651

Net Metering Programs
September 1996
NREL/SP-460-21427

Small Turbines in Distributed Utility Application:
Natural Gas Pressure Supply Requirements
May 1996
NREL/SP-461-21073

*See inside cover for instructions to order Topical Issues Briefs.

REPORT DOCUMENTATION PAGE	*Form Approved* *OMB NO. 0704-0188*

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE May 1999	3. REPORT TYPE AND DATES COVERED Topical Issues Brief

4. TITLE AND SUBTITLE
Grid-Connected Renewable-Electric Policies in the European Union

5. FUNDING NUMBERS
AS170100

6. AUTHOR(S)
Larry Goldstein, John Mortensen, and David Trickett

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
National Renewable Energy Laboratory
1617 Cole Boulevard
Golden, Colorado 80401-3393

8. PERFORMING ORGANIZATION REPORT NUMBER
TP-620-26247

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
U.S. Department of Energy
1000 Independence Ave., SW
Washington, DC 20585

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES
Part of the Topical Issues Brief series of publications.

12a. DISTRIBUTION/AVAILABILITY STATEMENT
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*
Policy, and other, efforts by the European Union have resulted in a dramatic increase in non-hydro renewable generating capacity in the European Union countries since 1990. These policies are aimed at reducing the cost of renewable technologies and at reducing market risks by making investments in renewable technologies more favorable. These efforts have substantially reduced the existing gap between installed renewable capacity in the United States and the European Union. This brief examines the policies that were most effective to promote renewables as well as lessons learned.

14. SUBJECT TERMS
Electric utility restructuring; deregulation; green power; retail competition, renewable-electric policies, European Union.

15. NUMBER OF PAGES
22

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
unclassified	Unclassified	Unclassified	UL

National Renewable Energy Laboratory

1617 Cole Boulevard
Golden, Colorado 80401-3393

NREL is a U.S. Department of Energy Laboratory
Operated by Midwest Research Institute • Battelle • Bechtel

Contract No. DE-AC36-98-GO10337